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AFPEA REPORT NO. 95-R-01
AFPEA PROJECT NO. 94-P-119

JASON M. GILREATH

Mechanical Engineer

DSN 787-3362
Comm. (513) 257-3362

Development of Handling Frames and Shipping Containers for 250AH Lithium Thionyl Chloride Batteries

AFMC LSO/LOP
PACKAGING BRANCH
5215 THURLOW ST BLDG 70
WRIGHT-PATTERSON AFB, OH 45433-5540

March 1995

PROJECT: 94-P-119
TITLE: 250AH Lithium Thionyl Chloride Battery Containers

ABSTRACT

The Martin-Marietta Corporation in conjunction with SAFT of France developed six batteries that needed to be shipped from Poitiers, France to Cape Canaveral, Florida in a very short time. The Aerospace Corporation was tasked with solving this problem. Aerospace designed a Lexan/Aluminum handling fixture that they believed would satisfy the requirements, but they needed assistance with the design of a container and cushioning system and fabrication of the fixtures. The Air Force Packaging Evaluation Activity (AFPEA) was asked to provide assistance.

Each battery had to be shipped separately inside an 85 gallon steel drum which was UN certified for shipment of hazardous materials. A polyethylene cushioning system was designed that would attenuate shock to 30 G's and a self-contained transport recorder that would measure shock and temperature accompanied each battery.

AFPEA fabricated and assembled the Lexan/Aluminum fixtures. Handle pull tests were also performed on the fixtures to provide Aerospace with the required assurances that their handling fixture would perform adequately.

MAN-HOURS: 150

PREPARED BY:

JASON M. GILREATH
Mechanical Engineer
AF Packaging Technology & Engineering Facility

PUBLICATION DATE: 25 APR 1995

REVIEWED BY:

TED HINDS
Supervisor, Design Group
AF Packaging Technology & Engineering Facility

APPROVED BY:

LESLIE K. CLARKE, III
Chief,
Packaging Branch

TABLE OF CONTENTS

APPENDICES

INTRODUCTION:

BACKGROUND:

The Martin-Marietta Corporation in conjunction with SAFT of France developed six batteries that needed to be shipped from Poitiers, France to Cape Canaveral, Florida in a very short time. These batteries contain an unusually large amout of Lithium, which is a hazardous material. Hazardous material shipment requires special attention to detail and safety. The Aerospace Corporation was tasked with solving this problem. Aerospace designed a Lexan/Aluminum handling fixture that they believed would satisfy the requirements, but they needed assistance with the design of a container and cushioning system and fabrication of the fixtures. The Air Force Packaging Evaluation Activity (AFPEA) was asked to provide assistance.

REQUIREMENTS:

AFPEA was to provide six deliverable sets of air cargo only transportation packaging for the 250AH Lithium Thionyl Chloride batteries as defined on the Aerospace Corporation drawing SK 104-1 (appendix 1) and its details. The packaging conforms to the Aerospace Corporation drawing SK 101 (appendix 2). The first setup was intended to ship an inert 'pathfinder' battery to ensure the shock and environmental requirements were being met. A self-contained transport recorder was attached to each fixture in order to record the shock and temperature data.

DESIGN:

CONFIGURATION:

The outer container is an 85 gallon steel drum that is UN certified for shipment of hazardous materials. The cushion (appendix 3) is made from laminated 2pcf polyethylene foam and is designed to attenuate shock levels to 30G's. The fixture to which the battery is bolted is made from a combination of GE Lexan, a high strength plastic, and aluminum plate and bar stock. Because the battery is transported at low temperatures and is loaded into the container at 0°F and must be kept as cold as possible during transit, the fixture and battery assembly is double bagged with shrink wrap, wrapped with Armaflex insulation, and then sealed inside a double-wall fiberboard box.

TESTING:

TEST SPECIMEN:

A concern was raised about the strength of the fixture handles. A handle pull test was conducted. AFPEA had fabricated enough parts to make seven complete fixtures, so there was no concern about damaging any critical parts. The test specimen was a complete fixture loaded with lead blocks (nominal 50 lb/ea).

TEST PLAN:

See appendix 4.

TEST RESULTS:
A handling fixture was loaded with lead weights totaling up to 600 lbs and hung free of support by both handles and also one single handle. I neither case did the handles fail or show signs of fracture.

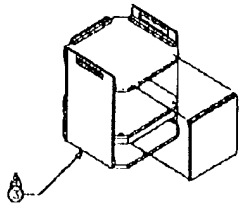
CONCLUSION:

The pathfinder battery container was completed and shipped on schedule. Results from the transport recorder showed shock levels well below the required 30 G's. The remaining batteries were to be shipped as scheduled because of the positive results seen in the pathfinder.

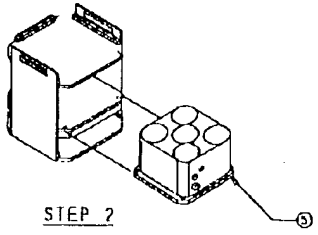
There was, however, a concern as to whether or not the handles were strong enough to provide a factor of safety of 2. A test was run to demonstrate the handle strength. Although the plain Lexan handles easily passed the pull test (Appendix 4), the users were not satisfied with the 'feel' of that configuration. An aluminum reinforcement was designed and installed on the remaining five fixture assemblies. With the newly reinforced handles, the remaining fixtures and containers were shipped without incident, successfully leaving France and arriving at Cape Canaveral.

APPENDIX 1

AEROSPACE DRAWING SK 104-1



STEP 1



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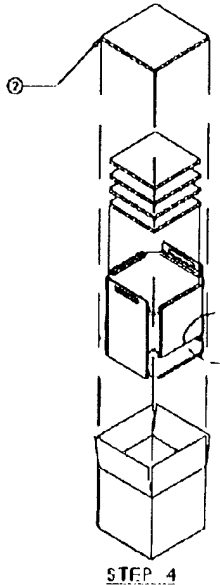
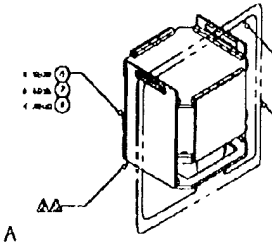
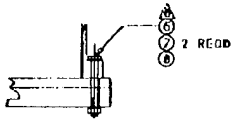


STEP 4

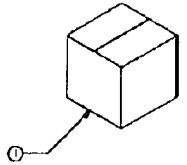
VIEW A



STEP 3



VIEW A
TYPICAL 4 PLACES



STEP 5

-1 CONFIGURATION ⚠

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	A	1. ADDED VIEW A 2. ADDED NOTE 6 3. REVISED LINES 2, 3 & 4 AND 3. 4. REVISED STEP 4 AND ADDED VIEW A 5. ADDED BAG PROFILES TO STEP 3.	10-21-94	B. DENNO

⚠ TORQUE TO 35 ±5 IN-LB.

⚠ REPLACE 6 MS2643-1/2", 6 MS 2647-1 1/4" FH SCREWS 6 8-32 STOP NUTS AND 6 #8 WASHERS

⚠ REMOVE 6 MS2643-1/2" 6 MS 2647-1 1/4" FH SCREWS 6 8-32 STOP NUTS AND 6 #8 WASHERS

⚠ BAG #1 TO BE TAPED AROUND PERIMETER OF EDR-3 RECORDER

⚠ DOUBLE BAG - GN2 PURGE - HEAT SEAL

⚠ -1 CONFIGURATION INCLUDES LITHIUM THIONYL CHLORIDE BATTERY PER GENERAL DYNAMICS SPECIFICATION 57-06060

NOTES:

DASH NO.	QTY REQD	ITEM	FSCM NO.	PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
4	4	8		MS51963-2	PLAIN HEXAGON NUT	
8	8	7		AN960C416L	FLAT WASHER	
4	4	6		MS90726 15	HEX HEAD CAP SCREW	
		5		⚠	BATTERY, PRIMARY	
1		4		SK 114	BATTERY, SIMULATED	
1	1	3		SK 102	FIXTURE, BATTERY	
1	1	2		SK 113	INSULATION, ARMAFLEX	
1	1	1		SK 112	BOX, SHIPPING, FIBERBOARD	
-3	-2	-1		PART NUMBER		

PARTS LIST

SK 101	SK 101
NEXT ASSY	USED ON
APPLICATION	

CONTRACTING

APPROVALS	DATE
DESIGNED A. DEVNO	9-14-94
CHECKED A. BAN	9-14-94
APPROVED L. MADURA	9-14-94

MATERIAL

FINISH

DO NOT SCALE DRAWING

THE AEROSPACE CORPORATION
EL SEGUNDO, CALIFORNIA

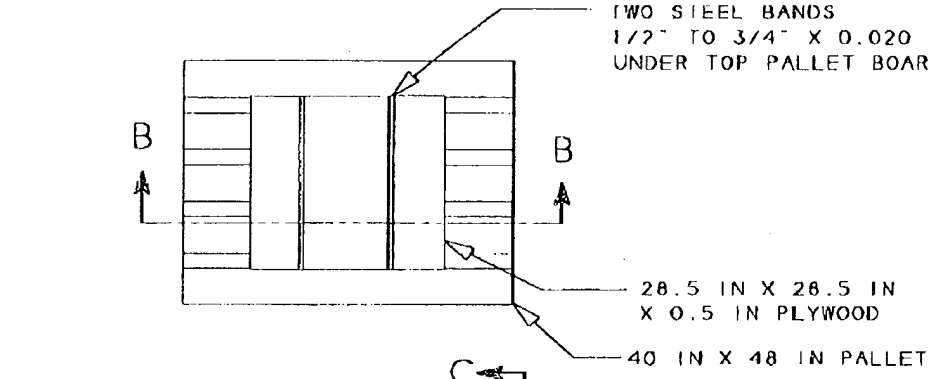
BOX ASSY SHIPPING - 250AH LITHIUM THIONYL CHLORIDE BATTERY

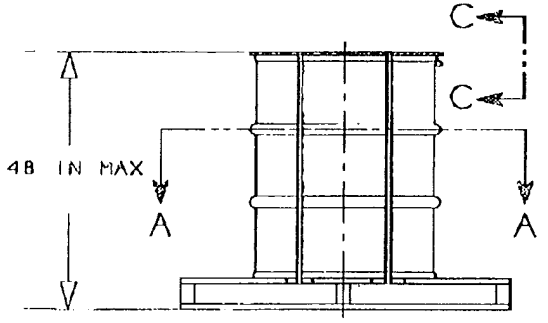
SIZE	FSCM NO.	DRAWING NO.	REV
B		SK 104	A

NEXT ASSY | USED ON | SHEET 1 OF 3

APPENDIX 2

AEROSPACE DRAWING SK 101





REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
03 04 03 04 03	A	1. ADDED PLYWOOD COVER 2. ADDED STEEL BANDS 3. DELETED NOTES: BOLTED RETENTION SYSTEM. 20 IN DIA MAX. 4. REVISED OVERALL HT. FROM 36" TO 48" 5. ADDED COVER CLAMP TORQUE	10-30-94	R. DENNO
C1	B	1. ADDED NOTES 3, 4 2. REVISED STEEL BAND NOTE: A. ADDED 1/2" B. 0.020 WAS 0.20 3. REVISED TOLERANCE BLOCK	11-1-94	R. DENNO

COMPLIES WITH CODE OF FEDERAL REGULATIONS TITLE 49

SHIPPING DESIGNATIONS
PROPER SHIPPING NAME: LITHIUM BATTERY, LIQUID CATHODE

UN NUMBER: 3090
HAZARD CLASS: 9
PACKING GROUP: II

4. FOR TRANSPORT OF DAMAGED OR DISCREPANT LITHIUM BATTERY. SEE SK 120
3. DEFINES ASSEMBLY FOR TRANSPORT EMPTY OR LOADED WITH ACCEPTABLE LITHIUM BATTERY.
2. STENCIL AND LABEL FOR SHIPMENT PER SK 118
1. MARKING FOR SHIPMENT AND STORAGE PER MIL-STD-129

NOTES:

PARTS LIST

THE AEROSPACE CORPORATION
EL SEGUNDO, CALIFORNIA

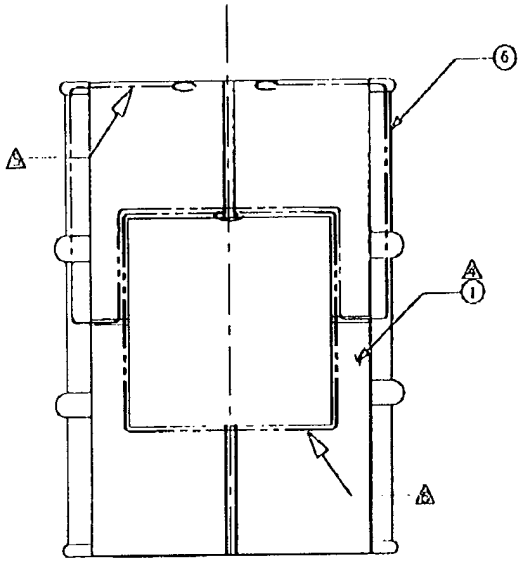
250AH LITHIUM THIONYL CHLORIDE BATTERY - TRANSPORTATION VIA AIR CARGO ONLY

APPROVALS	DATE
DRAWN R. DENNO	9-14-94
CHECKED R. FAN	9-14-94
APPROVED S. MAJEWSKI	9-14-94

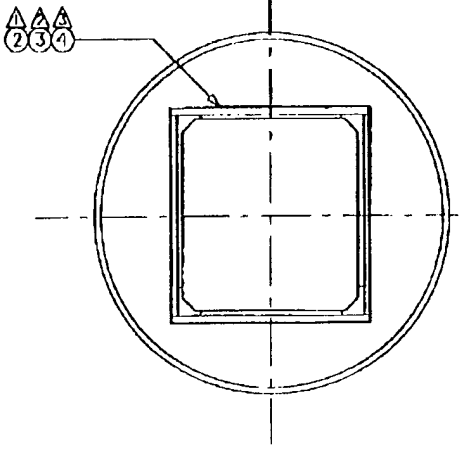
SK 101 REV. B

DO NOT SCALE DRAWING

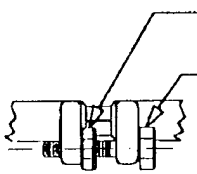
SCALE: NONE SHEET 1 OF 2



SECTION B-B



SECTION A-A
-1 ILLUSTRATED



VIEW C-C

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	A	6. DELETED BOP DRUM NOTE 3. 7. DELETED DRUM FROM NOTE 1.	10-20-94	R. DENNO
	B	4. ADDED VIEW C-C 5. ADDED STRAPS AND MODEL S.NO -9 6. ADDED ITEM 7	11-1-94	R. DENNO

ITEM	DASH NO.	PART NUMBER	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
7		SK 188	STENCIL AND LABEL REQUIREMENTS	
6	1	SK 189	DRUM, STEEL, OPEN HEAD, 85 GAL	
5				
4	-3	SK 104-3	BOX ASSY, SHIPPING	
3	-2	SK 104-2	BOX ASSY, SHIPPING	
2	-1	SK 104-1	BOX ASSY, SHIPPING	
1	-1	⚠	APEA ISOLATION SYSTEM	
QTY REQD			PARTS LIST	

THE AEROSPACE CORPORATION
EL SEGUNDO, CALIFORNIA

APPROVALS	DATE
DESIGNED R. DENNO	9-14-94
CHECKED B. PAN	9-14-94
APPROVED S. MASUDA	9-14-94

2SOAH LITHIUM THIONYL CHLORIDE BATTERY - TRANSPORTATION VIA AIR CARGO ONLY

SIZE	DRAWING NO.	REVISION NO.	REV.
B		SK 101	B

SCALE NONE | SHEET 2 OF 2

FINAL

MATERIAL | FINISH | CONTRACT NO. | FSC | APPLICATION | DO NOT SCALE DRAWING

⚠ PROVIDE 1/2 WIDE PLASTIC LIFTING STRAP AROUND (2)(3)(4)

⚠ PROVIDE 1/2" WIDE PLASTIC LIFTING STRAP AROUND UPPER CUSHION

⚠ ISOLATION SYSTEM PER APEA FAX DATED 9-14-94.
FABRICATE FROM POLYETHYLENE FOAM PER PPP-C-17520

⚠ -3 CONFIGURATION INCLUDES SIMULATED BATTERY FOR PATHFINDING

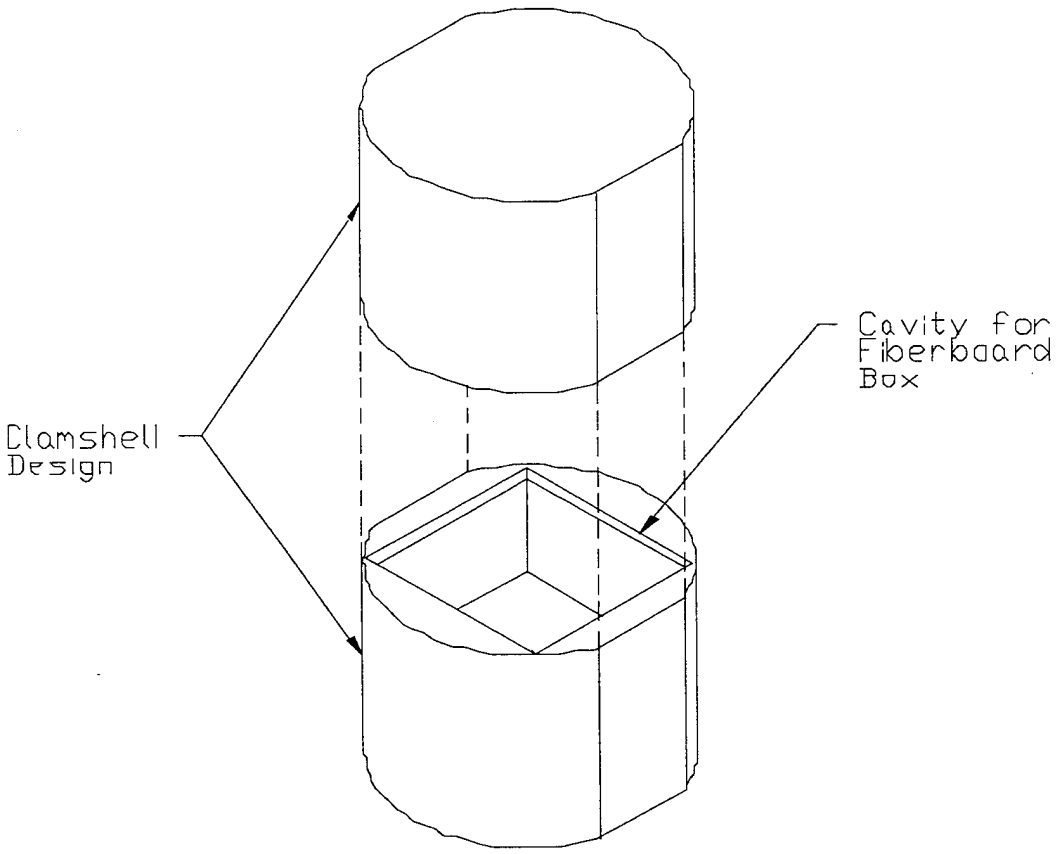
⚠ -2 CONFIGURATION DOES NOT INCLUDE LITHIUM THIONYL CHLORIDE BATTERY

⚠ -1 CONFIGURATION INCLUDES LITHIUM THIONYL CHLORIDE BATTERY
CONDITION DRUM CONTENTS TO 0° F FOR SHIPMENT

NOTES:

APPENDIX 3

POLYETHYLENE CUSHION


Clamshell
Design
Cavity for
Fiberboard
Box

APPENDIX 4

TEST PLAN/RESULTS

DEPARTMENT OF THE AIR FORCE

AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OHIO

MEMORANDUM FOR The Aerospace Corp.
2350 El Segundo Blvd.
El Segundo, Calif. 90245

FROM: AFMC-LSO/LGTP
5215 Thurlow Street
Wright-Patterson AFB OH 45433-5540

SUBJECT: Letter Report - 250AH Lithium Battery Fixture Handle Pull Test

1. Referencing telephone conversations between Dick Denno of Aerospace Corp. and Jason Gilreath of the Air Force Packaging Design Division, the Martin Marietta company felt the fixture handles were flimsy and would not satisfy a factor of safety of two (2) with a battery loaded in the fixture. Martin Marietta requested the Lexan handles be reinforced with aluminum plate in order to provide the needed strength.

2. A handle pull test was conducted to determine the acceptability of the existing handles. The 250AH Lithium Battery weighs 86 lbs. A test load of approximately 175 lbs would provide the required factor of safety of two (2). The first test consisted of a loaded fixture hanging free of support by both handles from a 2 inch wide cargo strap. The second test was to hang the loaded fixture by one single handle, also using a 2 inch wide cargo strap.

3. For both configurations, a lead test load of 600 lbs was used. This weight gives a factor of safety of approximately five (5) for two handles, and over ten (10) for a single handle. The maximum deflection when both handles were used was approximately 0.5" each (see figures 1 and 2). The maximum deflection for the single handle configuration was approximately 0.625" (see figures 3 and 4). In neither case did the handles fail or show signs of fracture.

4. Our point of contact is Mr. Jason Gilreath, at DSN 787-3362 or Comm (513) 257-3362, FAX 257-0231.

Leslie K. Clarke, III
Chief, AF Packaging Division

Attachment:
1. Figures 1 thru 4

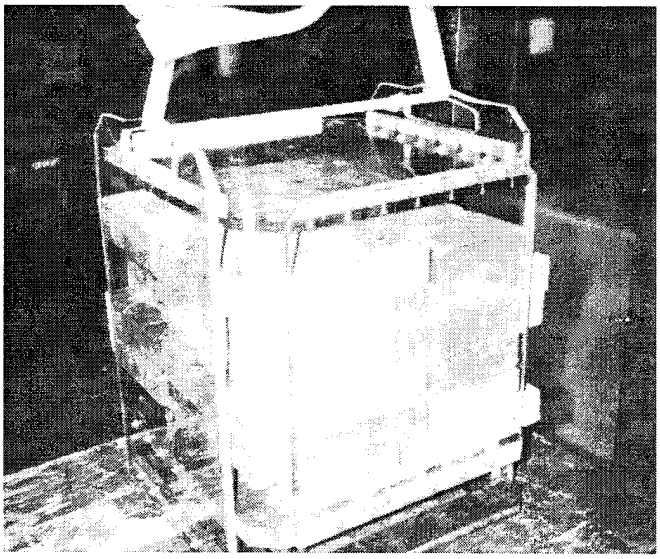


Figure 1

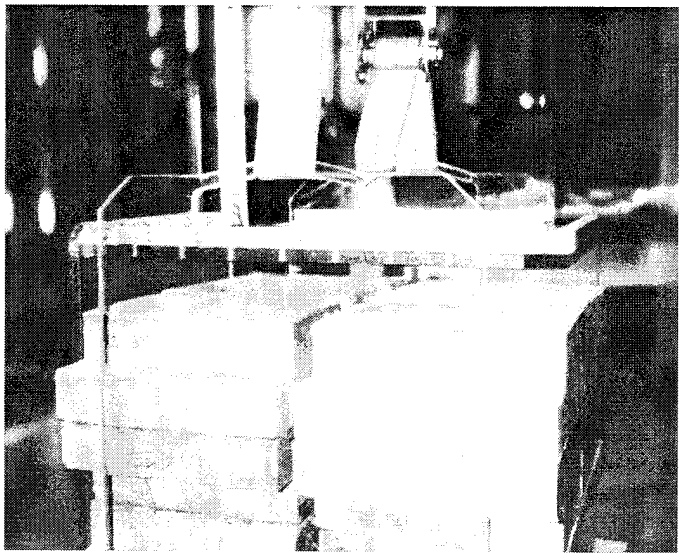


Figure 2

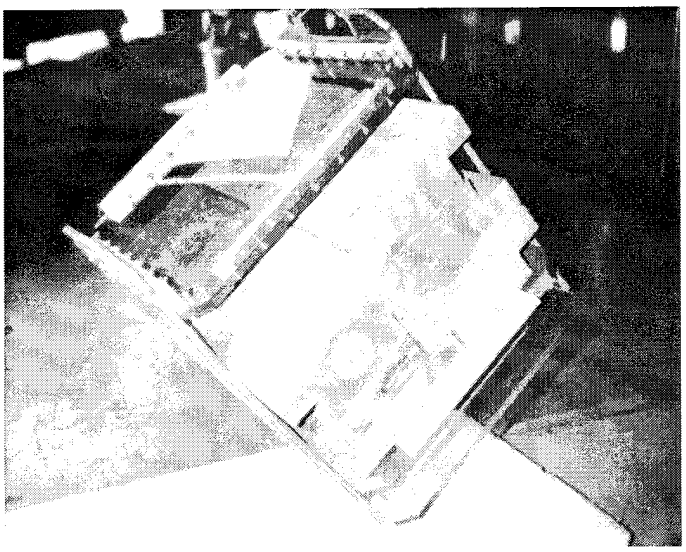


Figure 3

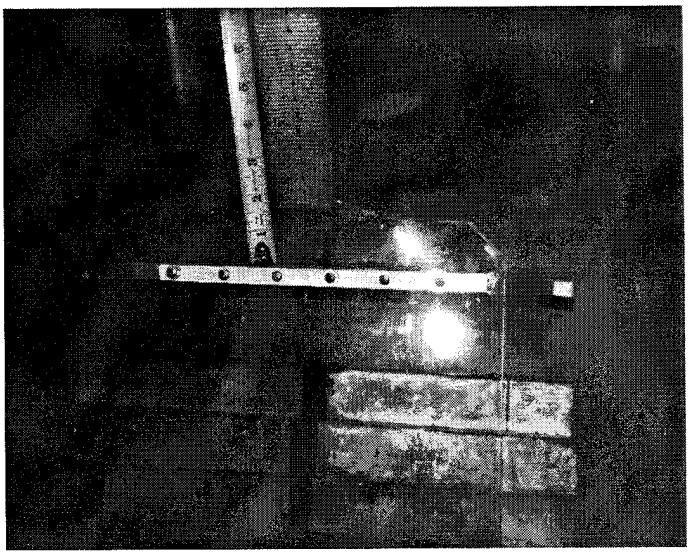


Figure 4

APPENDIX 5

DISTRIBUTION LIST

DISTRIBUTION LIST

DTIC/FDAC CAMERON STATION ALEXANDRIA VA 22304-6145	1
HQ AFMC/LG WRIGHT-PATTERSON AFB OH 45433-5006	1
AFMC LSO/LO WRIGHT-PATTERSON AFB OH 45433-5006	1
AFMC LSO/LOP (LIBRARY) WRIGHT-PATTERSON AFB OH 45433-5540	10
HQ USAF/LGTT WASHINGTON DC 20330	1
654 ABG/LGT 7701 SECOND ST, STE 209 TINKER AFB OK 73145-9100	1
654 ABG/LGTP 7701 SECOND ST, STE 209 TINKER AFB OK 73145-9100	1
649 ABG/LGT BLDG 1135 7973 UTILITY DR HILL AFB UT 84056-5713	1
649 ABG/LGTP 7530 11th ST HILL AFB UT 84056-5707	1
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651 ABG/LGTP 401 WISON BLVD KELLY AFB TX 78241-5340	1

DISTRIBUTION LIST (Cont'd)

652 ABG/LGT 1
1961 IDZOREK ST
MCCLELLAN AFB CA 95652-1620

652 ABG/LGTP 1
1961 IDZOREK ST
MCCLELLAN AFB CA 95652-1620

653 ABG/LGT BLDG 376 1
455 BYRON ST
ROBINS AFB GA 31098-1860

653 ABG/LGTP BLDG 376 1
455 BYRON ST
ROBINS AFB GA 31098-1860

ASC/AWL 1
WRIGHT-PATTERSON AFB OH 45433

ASC/ALXS 1
WRIGHT-PATTERSON AFB OH 45433-7642

ASC/YJA 1
110 WACISSA RD
SUITE 15
EGLIN AFB FL 32542-5313

GSA OFFICE OF ENGINEERING MGT 1
PACKAGING DIVISION
WASHINGTON DC 20406

COMMANDER 1
ATTN: N KARL (SUP 045)
NAVAL SUPPLY SYSTEMS COMMAND
WASHINGTON DC 20376-5000

COMMANDER 1
ATTN: E PANIGOT (AIR 41212A)
NAVAL AIR SYSTEMS COMMAND
WASHINGTON DC 20361

DISTRIBUTION LIST (Cont'd)

COMMANDER 1
ATTN: T CORBE (CODE 8218)
SPACE AND NAVAL WARFARE SYSTEMS COMMAND
WASHINGTON DC 20360

ATTN: C MANWARRING (FAC 0644) 1
NAVAL FACILITIES ENGINEERING COMMAND
HOFFMAN BLDG 2 ROOM 12S21
ALEXANDRIA VA 22332

COMMANDING OFFICER 1
ATTN: K POLLOCK (CODE 15611K)
NAVAL CONSTRUCTION BATTALION CENTER
PORT HUENEME CA 93043

COMMANDER 1
NAVAL SEA SYSTEMS COMMAND
ATTN: G MUSTIN (SEA 66P)
WASHINGTON DC 20362

COMMANDER 1
ATTN: F BASFORD (SEA 05M3)
NAVAL SEA SYSTEMS COMMAND
WASHINGTON DC 20362

ATTN: E. H. BRIGGS (CODE 0512) 1
NAVAL AVIATION SUPPLY COMMAND
700 ROBBINS AVENUE
PHILADELPHIA PA 19111-5098

ATTN: F SECHRIST (CODE 0541) 1
NAVY SHIPS PARTS CONTROL CENTER
PO BOX 2020
MECHANICSBURG PA 17055-0788

COMMANDING OFFICER 1
ATTN: F MAGNIFICO (SESD CODE 9321)
NAVAL AIR ENGINEERING CENTER
LAKEHURST NJ 08733-5100

DISTRIBUTION LIST (Cont'd)

COMMANDING OFFICER 1
NAVAL WEAPONS STATION EARLE
NWHC/CODE 8023
COLTS NECK NJ 07722-5000

US AMC PACKAGING STORAGE AND 1
CONTAINERIZATION CENTER/SDSTO-TE-E
16 HAP ARNOLD BLVD
TOBYHANNA PA 18466-5097

DLSIE/AMXMC-D 1
US ARMY LOGISTICS MGT CTR
FT LEE VA 23801-6034

ATTN: Mike Ivankoe 1
US ARMY ARDEC/SMCAR-AEP
DOVER NJ 07801-5001

US ARMY NATICK LABS/STRNC-ES 1
NATICK MA 01760

HQ AFMC/LGSH 1
WRIGHT-PATTERSON AFB OH 45433

ASC/SDM 1
WRIGHT-PATTERSON AFB OH 45433

ATTN: DLA-MMDO 1
DEFENSE LOGISTICS AGENCY
CAMERON STATION
ALEXANDRIA VA 22304-6100

ATTN: DLA-AT 1
DEFENSE CONTRACT MANAGEMENT COMMAND
CAMERON STATION
ALEXANDRIA VA 22304-6190

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NEWARK AFS 43057-5000

AMARC/DST 1
DAVIS MONTHAN AFB AZ 85707-5000

DISTRIBUTION LIST (Cont'd)

2750 TRANS/DMTT WRIGHT-PATTERSON AFB OH 45433-5001	1
HQ PACAF/LGTT HICKAM AFB HI 96853-5000	1
HQ USAFE/LGTT APO NEW YORK 09094-5000	1
HQ ACC/LGTT LANGLEY AFB VA 23665-5001	1
HQ AFSPACECOM/LKT PETERSON AFB CO 80914-5000	1
HQ ANGSC/LGTT ANDREWS AFB MD 20331-6008	1
HQ ATC/LGTT RANDOLPH AFB TX 78150-5001	1
HQ AU/LGTT MAXWELL AFB AL 36112-5001	1
HQ AMC/XONC SCOTT AFB IL 62225-5001	1
SCHOOL OF MILITARY PACKAGING TECHNOLOGY ATSZ-MP ABERDEEN PROVING GROUND MD 21005-5001	1
HQ USMC (CPP-2) WASHINGTON DC 20380	1
ATTN: DGSC/QED DEFENSE GENERAL SUPPLY CENTER 8100 JEFFERSON DAVIS HIGHWAY RICHMOND VA 23297-5000	1

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ATTN: DGSC/OMAD 1
DEFENSE GENERAL SUPPLY CENTER
8100 JEFFERSON DAVIS HIGHWAY
RICHMOND VA 23297-5000

ATTN: DICK DENNO 1
M6/206
THE AEROSPACE CORPORATION
P. O. BOX 92957
LOS ANGELES, CALIFORNIA 90009

ATTN: MAJOR KEVIN KLONOSKI 1
2420 VELA WAY SUITE A5-1467
LOS ANGELES, CALIFORNIA 90245-4659

APPENDIX 6

REPORT DOCUMENTATION

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	25 Apr 95	Final Aug 94 - Mar 95

4. TITLE AND SUBTITLE
Development of Handling Frames and Shipping Containers for 250AH Lithium Thionyl Chloride Batteries

5. FUNDING NUMBERS

6. AUTHOR(S)
Jason Gilreath

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
AFPTEF
AFMC LSO/LOP
Bldg. 70, Area C

8. PERFORMING ORGANIZATION REPORT NUMBER
95-R-01

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release. Distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This report is to document the design and fabrication of six shipping containersassemblies for the 250AH Lithium Thionyl Chloride batteries manufactured by the Martin-Marietta Corporation in France. The handling frame is a combination of aluminum and GE Lexan. The cushion system is polyethylene foam, and the outer container is a UN-certified steel drum. The container passed a field test (shipment of a unit through the supply system). The containers were fabricated wholly in-house at the Air Force Packaging Technology & Engineering Facility.

14. SUBJECT TERMS	15. NUMBER OF PAGES
250 AH Lithium Thionyl Chloride batteries, Lexan handling frame	14
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	